Canonical correlation analysis of course and teacher evaluation

Sliusarenko, Tamara; Ersbøll, Bjarne Kjær

Published in:
Canonical correlation analysis of course and teacher evaluation

Publication date:
2010

Document Version
Publisher's PDF, also known as Version of record

CANONICAL CORRELATION ANALYSIS OF COURSE AND TEACHER EVALUATIONS

Tamara Sliusarenko, Bjarne Kjær Ersbøll
DTU Informatics, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark
tasl@imm.dtu.dk, be@imm.dtu.dk

Keywords: course evaluation, teacher evaluation, student questionnaire, canonical correlation, higher education.

Abstract: At the Technical University of Denmark course evaluations are performed by the students on a questionnaire. On one form the students are asked specific questions regarding the course. On a second form they are asked specific questions about the teacher. This study investigates the extent to which information obtained from the course evaluation form overlaps with information obtained from the teacher evaluation form. Employing canonical correlation analysis it was found that course and teacher evaluations are correlated. However, the structure of the canonical correlation is subject to change with changes in teaching methods from one year to another.

1 INTRODUCTION

Teacher evaluations and overall course quality evaluations are widely used in higher education. Students usually submit their feedback about the teacher and the course anonymously at the end of the course. Results are usually employed to improve courses for future students and to improve the instructor's effectiveness. Many researchers have stated that student rating is the most valid and practical source of data on teaching and course effectiveness (McKeachie, 1997). Therefore, research on student evaluations is critical to make improvements in course construction and teaching methods.

Many studies have been done based on the data from student evaluation addressing the relationship between student rating and student achievement (Cohen, 1981; Abrami et al. 1997). The main conclusion is that the student's achievement is correlated with the student's evaluation of the teacher and the course.

The purpose of this research is to investigate the degree of association between students' evaluation of the course and students' evaluation of the teacher. This is done using canonical correlation analysis, which is designed to investigate correlations amongst two sets of variables. The other question we are trying to address is whether this association is consistent over time.

2 DATA AND METHODS

2.1 Data source and study sample.

This research is based on questionnaire data from course evaluations at the Technical University of Denmark (DTU). Online course evaluation is performed a week before the final week of the course. This usually means in week 12 out of 13 weeks of teaching. Two samples of observations from the introductory statistics course taught by the same instructor in two subsequent years were analysed: 131 observations from autumn 2007 and 183 observations from autumn 2008.

The questionnaire at DTU consists of three parts: Form A contains questions about the course; Form B contains questions about teacher. Finally, form C contains three open questions; that gives the students the opportunity to write their feedback "What went well?"; "What did not go so well?"; "Suggestions for changes". This particular analysis is based on investigation of the relationship between Form A and Form B. Questions used in this research are presented in Table 1 and Table 2 respectively.

Table 1:Example of questions in Form A.

	Question
A.1.1	I think I am learning a lot in this course
A.1.2	I think the teaching method encourages my active participation
A.1.3	I think the teaching material is good
A.1.4	I think that throughout the course, the teacher has clearly communicated to me where I stand academically
A.1.5	I think the teacher creates good continuity between the different teaching activities
A.1.6	5 points is equivalent to 9 hours per week. I think my performance during the course is
A.1.7	I think the course description's prerequisites are
A.1.8	In general, I think this is a good course

Table 2: Example of questions in Form B.

	Question
B.1.1	I think that the teaching gives me a good grasp of the academic content of the course
B.1.2	I think the teacher is good at communicating the subject
B.1.3	I think the teacher motivates us to actively follow the class

Each student has five possibilities to rate questions from 5 to 1, where 5 means that the student strongly agrees with the underlying statement and 1 means that the student strongly disagrees with statement. For question A.1.6 5 corresponds to "much less" and 1 to "much more", while for A.1.7 5 corresponds to "too low" and 1 to "too high".

2.2 Methodology

Canonical correlation analysis (CCA), introduced by Hotelling (1935, 1936), was performed to investigate the degree of association between the evaluation of the teacher and the evaluation of the course. CCA is a convenient method to investigate what is common amongst two sets of variables in a linear sense, and can also be used to produce a model equation which relates two sets of variables. It has similarities with both multivariate regression and principal component analysis

The main idea behind CCA is to find canonical variables in the form of two linear combinations (1):

$$\begin{aligned} w_1 &= a_{11}x_1 + a_{21}x_2 + \ldots + a_{n1}x_n \\ v_1 &= b_{11}y_1 + b_{21}y_2 + \ldots + b_{m1}y_m \end{aligned} \quad (1)$$

such that the coefficients a_{1i} and b_{1i} maximize the correlation between two canonical variables w_i, and v_1. This maximal correlation between the two canonical variables is called the first canonical correlation. The coefficients of the linear combinations are called canonical coefficients or canonical weights.

The method continues by finding a second set of canonical variables, uncorrelated with the first pair that has maximal correlation, which produces the second pair of canonical variables. The maximum number of canonical variables is equal to the number of variables in the smaller set. A likelihood ratio test was used to investigate statistical significance of canonical correlations.

3 RESULTS

3.1 Evidence from the data

From the simple descriptive statistics presented in Table 3 it is evident that there is a difference in student rating between 2007 and 2008 in both parts: the course and the teachèr evaluation.

Table 3: 2007 and 2008 sample descriptive statistics.

	Autumn 2007		Autumn 2008	
Question	Mean	Standard Deviation	Mean	Standard Deviation
A.1.1	4.34	0.74	4.02	0.76
A.1.2	4.11	0.84	3.91	0.83
A.1.3	3.98	0.88	3.88	0.95
A.1.4	3.52	1.06	3.24	1.06
A.1.5	4.20	0.79	4.03	0.83
A.1.6	3.24	0.69	3.40	0.71
A.1.7	2.98	0.19	3.02	0.23
A.1.8	4.31	0.73	4.09	0.82
B.1.1	4.66	0.54	4.34	0.81
B.1.2	4.79	0.46	4.48	0.76
B.1.3	4.73	0.53	4.40	0.83
#observ	131		183	

The highest rated course specific questions in both years about the course are A.1.1 "I think I am learning a lot in this course" and A.1.8 "In general, I think this is a good course.", but the rating is lower in 2008 than in 2007. On average students rate both course and the teacher better in 2007 than in 2008. This difference may be explained by the fact that in autumn 2007 the course was taught in the way of normal lecturing, but in autumn 2008 it was also covered by video.

3.2 Autumn semester 2007

The first canonical correlation was found to be equal to 0.64. This gives an overall indication of the degree of association between teacher and course

evaluation. It is the only canonical variable which is significant (p-value < 0,0001), which indicates that the two sets of variables are correlated in only one dimension.

Table 4: Canonical structure analysis of 2007 sample

	Standardized Canonical Coefficients	Canonical factor loadings	Canonical cross-loadings
A.1.1	0.22	**0.78**	**0.50**
A.1.2	0.01	**0.73**	0.47
A.1.3	-0.07	0.38	0.24
A.1.4	-0.02	0.37	0.24
A.1.5	**0.46**	**0.82**	**0.53**
A.1.6	-0.10	-0.04	-0.03
A.1.7	-0.08	-0.14	-0.09
A.1.8	**0.51**	**0.89**	**0.57**
B.1.1	**0.82**	**0.98**	**0.63**
B.1.2	0,12	0,78	0,50
B.1.3	0,14	0,71	0,45

The next question that arises is "how do we interpret the canonical variables?". To answer this question standardized canonical coefficients should be investigated. These coefficients are reported in the first column of Table 4. We can see that in the canonical variable of the course evaluation questions A.1.5 (I think the teacher creates good continuity between the different teaching activities) and A.1.8 (In general, I think this is a good course) have the highest weights. In the teacher related canonical variable question B.1.1 (I think that the teaching gives me a good grasp of the academic content of the course) is the most important.

Structure correlation coefficients, called canonical factor loadings, are also used to interpret the importance of each original variable in the canonical variables. Canonical factor loading is the correlation between the original variables and the canonical variables. Variables with high canonical factor loading should be interpreted as being a part of the canonical variable.

The first set of loadings between course evaluation variables and their canonical variable are presented in the second column of Table 4. Questions A.1.5 and A.1.8 have the highest correlation with the course related canonical variable. However, questions A.1.1 (I think I am learning a lot on this course) and A.1.2 (I think the teaching method encourages my active participation) also have high canonical factor loadings. Question B.1.1 has the highest correlation with the teacher related canonical variable.

Next we look at the cross correlations between the original course evaluation variables and the canonical variables of the teacher evaluation variables presented in the third row of Table 4. We can see that questions A.1.5 and A.1.8 also have the highest cross-correlations with the teacher related canonical variable, questions A.1.1 also has quite a high canonical cross-loading. Question B.1.1 has the highest cross-correlation with the course related canonical variable.

An overall conclusion that can be made is that the canonical correlation of 0.64 in the autumn 2007 introductory statistics course is mainly due to the relationship between the teachers ability to give a good grasp of the academic content of the course from one side and a good continuity between teaching activities in the course, good content of the course and good overall quality of the course on the other side.

3.3 Autumn semester 2008

As in the case of autumn semester 2007 only the first canonical correlation, equal to 0.71, appears to be significantly different from zero (p-value<0,0001).

Table 5: Canonical structure analysis of 2008 sample.

	Standardized Canonical Coefficients	Canonical factor loadings	Canonical cross-loadings
A.1.1	**0.39**	**0.88**	**0.62**
A.1.2	**0.47**	**0.87**	**0.62**
A.1.3	-0.03	0.61	0.43
A.1.4	0.08	0.40	0.28
A.1.5	0.17	0.71	0.51
A.1.6	0.03	-0.09	-0.07
A.1.7	0.08	-0.04	-0.03
A.1.8	0.16	**0.76**	**0.54**
B.1.1	**0.43**	0.89	0.63
B.1.2	0.11	0.90	0.64
B.1.3	**0.55**	**0.94**	**0.67**

Analyzing the standardized canonical coefficients from the first column of Table 5 we can conclude that in the canonical variable of the course evaluation question A.1.1 (I think I am learning a lot on this course) and question A.1.2 (I think the teaching method encourages my active participation) are important. In the teacher related canonical variable questions B.1.1 (I think that the teaching gives me a good grasp of the academic content of the course) and B.1.3 (I think the teacher gives me useful feedback on my work) are important.

Analysis of the canonical factor loadings, presented in the second and third columns of Table 5, shows that questions A.1.1, A.1.2 and A.1.8 have

the highest correlations with their canonical variable. We can also see that the same three questions have the highest cross-correlation with the teacher evaluation canonical variable. Question B.1.3 has the highest correlation and cross-correlation with the corresponding canonical variables.

An overall conclusion is that the canonical correlation of 0,71 in the autumn semester 2008 course is mainly due to the relationship between the teacher's ability to motivate the students and a good teaching method that encourages active participation in the course, good course content, and overall quality of the course. This difference can be explained by the change in teaching method from normal lectures in 2007 to combined lectures and video sequences, which could be replayed by the students, in 2008. This was reflected to a very high degree in the verbal comments in form C.

Examples of verbal comments from 2007 are very much focused on the teacher: "Good dissemination", "Teacher seems pleased with his course", "Engaged teacher", "Gives a really good overview", "Inspiring teacher". Examples of verbal comments from 2008 on the other hand to a very large extent are concerned with the new teaching method: "Good idea to record the lectures – useful for preparation for the exam", "The possibility of downloading the lectures is fantastic", "Really good course, the video recordings really worked well!"

4 CONCLUSIONS

This study analyses the association between how students evaluate the course and how students evaluate the teacher in two subsequent years, using canonical correlation analysis. This association was found to be quite strong in both years: higher in 2008 than in 2007. The structure of the canonical correlations appears to be different for these two years. This is accounted for by the change in teaching method used by the same teacher in the two different years: in 2007 it was normal lecturing, but in 2008 it was also covered by video - and the students really liked that. Therefore, question A.1.2 that concerns the teaching method has more impact on the correlation between course evaluation and teacher evaluation in 2008 than in 2007. In 2008 the teacher's motivation for the students to actively follow the class has major impact on the correlation between the teacher evaluation and the course evaluation instead of good academic grasp as in 2007.

5 FUTURE WORK

This paper is the early stage of comprehensive research on student evaluation at the Technical University of Denmark. Questions we would like to address in future work include consistency of the evaluation in courses over time, across courses, and comparison of mandatory vs. elective courses. The study will also investigate the relationship between students' achievements and students' rating of the teacher and the course (Ersbøll, 2010). Furthermore, we will investigate whether student specific characteristics such as age, gender, years of education, etc have relationship with the student evaluation and achievement. Information from qualitative answers is also important, so some text-mining type methods will be used in order to utilize information from Form C.

REFERENCES

Abrami, P.C., d' Apollonia, S, Rosenfield, S., 1997. The dimensionality of student ratings of instruction: what we know and what we do not. In *Perry, R.P., Smart J.C., editors: effective teaching in higher education: research and practice.*, New York: Agathon Press.

Cohen, P. A. 1981. Student rating of instruction and student achievement. *Review of Educational Research*; 51(3): 281-309.

Cohen, J., Cohen, P., West S. G. Aiken, L. S., 2003. *Applied multiple regression/correlation analysis for the behavioural sciences.*; 3rd ed. Mahwah(NJ): Lawrence Erlbaum.

Ersbøll B.K. 2010. Analyzing course evaluations and exam grades and the relationships between them., *paper accepted to be published at CSEDU 2010.*

Feldman, K.A., 1989. The association between student ratings of specific instructional dimensions and student achievement: Refining and extending the synthesis of data from multisection validity studies. *Research in Higher education*, Vol. 30, No 6.

Hotelling, H., 1935. The most predictable criterion. *Journal of Educational Psychology*, Vol. 26: 139-142.

Hotelling H., 1936, Relation Between Two Sets of Variates, *Biometrika*. 28(3-4):321-377

McKeachie, W.J., 1997 Student Ratings: Their Validity of Use, *American Psychologist*, Vol. 52, 1218-1225

SAS Institute, 2009, SAS 9.2 User's Guide, 2nd ed.

Thompson B. 1984. Canonical correlation analysis: uses and interpretation. In: *Quantitative applications and social sciences.* Vol. 47 of Sage university papers. 2nd ed.